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Eastward Extension of Ancestral Rocky Mountains Geosyncline into Iowa

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strata, the Devonic, and earlier rocks, while by this time Pacific waves roll over our State. This marine deposit reclines upon our Des Moines series of coal measures at ever higher and higher horizons.

This record of the great marine transgression into Iowa finds expression in our Bethany limestone, which proves to be only one out of many successive eastward extensions of the Pacific-born Aubreyan limestone, overlapping, and interdigitating with littoral clays, and betokening vigorous oscillatory movements of the old sea-bottom.

Diagrammatically represented the terranal relationships of the several provencial series are about as indicated in the annexed cut (figure 1).

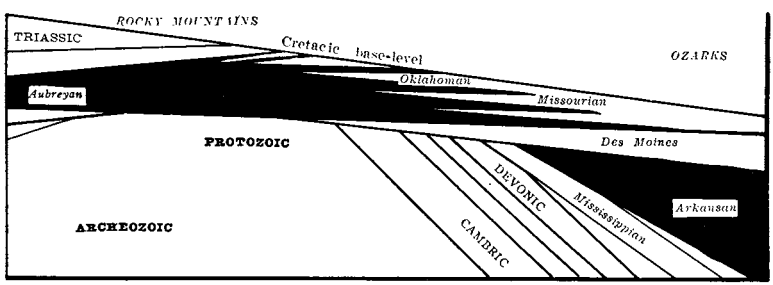

Fig. 1. Stratigraphy of Carbonic Rocks in Continental Interior

Thus, the stratigraphic relationships of our lower coal measures and upper coal measures, instead of being those of contemporaneous deposition of littoral and pelagic formations along the same horizon, as might be inferred from the descriptions in the early reports [2] of our Iowa Geological Survey, are rather these of distinct overlap and unconformity, a feature which none of the critics of the early notion bring out.

EASTWARD EXTENSION OF ANCESTRAL ROCKY MOUNTAINS GEOSYNCLINE INTO IOWA

CHARLES KEYES

Despite the circumstance that in the Iowa part of the Great Plains, lying between the Mississippi River and the Rocky Mountains, the deep well-drillings usually sink only to that famed aquifer, or artesian reservoir, the Peter sandstone, the ancient crystalline basement beneath all of the tall column of sedimentaries is entered in a number of instances. Touching the deeply buried

2 Iowa Geol. Surv., Vol. I, p. 118, 1893; also, *Ibid.*, Vol. II, p. 161, 1894.

pre-Cambric rocks in the northeastern part of the State is not so surprising inasmuch as soon beyond our boundaries these crystallines rise to the surface.

In the other direction, to the westward, the usual inference is that the old crystallines are inclined so steeply as to offer no hope of their ever being revealed there. Recent finding of the basement masses in a number of deep drill-holes, beyond the Missouri River, demonstrates that in spots, or in belts, they come very much nearer the surface than most sanguine expectations seemed to warrant. The fact gives clue to what the Paleozoic tectonics really are in the Great Plains region.

Our western exposures of the Sioux quartzite relate to orographic events more recent than the laying down of our coal measures. In central Kansas the latter recline directly upon some of the old granites. Farther south, of course, in Oklahoma and Texas the ancient crystallines also come to the surface.

Some of the cases of penetrating granite in the deep-drillings are noted by Professor Gould,[1] of Oklahoma; but there are a number of early records that are of great interest.

In late years deep-drilling for oil and gas, in eastern Kansas and Oklahoma especially, bottom in "granite" in places. It fundamentally changes our ideas in regard to the stratigraphy of these and the adjoining states. This deep-drilling for oil and gas reveals in no uncertain terms that throughout much of the Great Plains region the old crystalline basement actually lies relatively very near the surface.

First suspicions that the fundamental complex in the Kansas-Oklahoma region might be very much nearer the surface than had been previously regarded appear to have been aroused in 1891, when drillers brought into the office of the Missouri Geological Survey, at Jefferson City, a section of a core from the bottom of a drillhole, 2400 feet deep, put down near Kansas City, in 1886. The drill had gone entirely through the stratified column, and had entered "granite." This core-fragment, however, was a well-defined biotitic schist.[2]

There are, indeed, still earlier records of deep-drilling ending in "granite," which are wholly overlooked by later writers. So early as 1881 Mudge [3] notes a "metamorphic deposit found in Woodson County, Kansas." Two years afterwards Hay [4] describes the "igneous rocks of Kansas;" and a decade afterwards [5] he has a

1 Bull. Geol. Soc. America, Vol. XXXIV, p. 541, 1923.
2 Missouri Geol. Surv., Vol. VIII, p. 334, 1895.
3 Trans. Kansas Acad. Sci., Vol. VII, pp. 12-13, 1881.
4 *Ibid.*, Vol. VIII, pp. 14-18, 1883.
5 *Ibid.* Vol. XIII, pp. 75-76, 1893.

"note on the occurrence of granites on deep-borings in eastern Kansas." In Nebraska so early as 1883 Prof. L. E. Hicks [6] refers to a diamond-drill hole put down at Pawnee City, in the southeastern corner of the State, 100 miles north of Kansas City, which reaches the crystalline schists at only 560 feet, and, as is alluded to by Todd,[7] tends to confirm the surmise of the closeness of the pre-Cambric rocks to the present prairie surface.

On the other hand, to the south of Kansas City, 125 miles, the Carthage drill-hole reveals the red, pre-Cambric porphyries of the central Ozarks at a depth of 1750 feet;[8] while on Spavanaw Creek, another hundred miles farther south, as first noted by Owen,[9] the top of a granite monadnock of pre-Cambric date is now being uncovered through present-cycle erosion. Still farther southward, or southwestward, 160 miles southwest of the Spavanaw locality, near Tismingo, Oklahoma, is another outcrop of the red, pre-Cambric granites described by Hill.[10]

Here, then, near the present Kansas-Missouri boundary is certainly a buried ridge of the basal complex, a part in all likelihood of a regional pre-Cambric diversified surface such as is already brought to sky in the St. Francois Mountains of southeastern Missouri. Are there other and similar buried ridges to the west in Kansas and Oklahoma? Do they, if existant, form a part of an ancestral Rocky Cordillera which is base-leveled in Paleozoic times? Do the present-day Rockies constitute only that portion of a much broader orographic belt that is so recently elevated, while the other half remains dormant far to the eastward under its thick covering of Mesozoics? These questions could not then be answered at once. In long years after the main theme is reached from a different and distant angle.

Now, from the records of the numerous deep drill-holes, the recent revelations regarding the erosional unconformities within the coal measures, and the repeated upraisings of the Rocky Mountains, we appear to have sufficient data to support the theses that the ancestral Rocky Mountain geosyncline once extended eastward to the Missouri River and that now one-half of those ancestral Rockies base-leveled and deeply buried, repose beneath the surface of the Great Plains.

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6 Proc. Am. Assoc. Adv. Sci., Vol. XXXV, p. 217, 1889.
7 American Geologist, Vol. XV, p. 64, 1895. Rept. Ill. Map. Hydro, Basin of Upper Mississippi River, 1843.
8 Missouri Geol. Surv., Vol. VIII, p. 334, 1894.
9 Arkansas Geol. Surv., 2nd Rept., p. 16, 1860.
10 American Geologist, Vol. VI, p. 252, 1890.